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Ohio Mining Journal

Title: Coking: and Coke from Ohio Coals

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Issue Date: 15-Apr-1885

Citation: Ohio Mining Journal, vol. 3, no. 3 (May 15, 1885), 40-46.

URI: <http://hdl.handle.net/1811/32413>

Appears in Collections: [Ohio Mining Journal: Volume 3, no. 3 \(May 15, 1885\)](#)

COKING,

And Coke From Ohio Coals.

BY FRED. W. GORDON.

Commercially speaking, coking is the expulsion of the volatile materials from the coal without too large a percentage of the carbon, leaving a compact, tenacious and perfectly lustrous coke. This must necessarily contain all the non-volatile impurities of the coal.

The coke producing coal area is exceedingly limited, contrasted with the wide range of our bituminous coals. Ohio may be said to possess no coking coals, and depends upon the Connellsville

Coke, so called for her smelting fuels, her fine lake ports giving the most ready access to the greatest of our ore territory, would place her in the van of the iron producing States, if her vast and most excellent fuels could be treated successfully to produce good coke. To this question Ohio should address herself to an energy worthy of so important a subject. The attempt to ascertain the coking qualities of coals nearly all result in failures. Sending a car or two of coal to the coking region only demonstrates whether it could be treated by their practice, and it may often happen that it would not be to the interest of those to whom the coal is sent, to make an unqualified success of the experiment. To erect ovens under the supervision of a practical coke maker can effect no better result. This practical man so often harped upon, is but the imperfectly taught machine of perhaps a by-gone intelligence, whose art has been transmitted to him as a legend, and is as much mixed with superstition. He may be capable of repetition of manipulations to practical perfection, but intelligent deviation is beyond his sphere. Those who depend upon practical men may succeed where nothing new is essential, and where nothing new is desired. But where a proposition is to be mastered, he is the worst of all appendages, as his prejudice interferes to check a possible thought. Those who trust to the practical man, are always themselves ignorant, and fear to treat with intelligence beyond their ken. They accept the machine instead of the constructor, simply because they cannot detect the impostor. The glib tongue smattering incident to a limited education deceives them, and this is condemned as theory against practice. Practice must be based on theory, or it is the result of accident. The theoretical man should be he who knows how to perform intelligently, the practical man, he who performs by rote.

Coke intelligently, and to do this, know the complete analysis of the coals to be treated; thoroughly investigate the chemical and mechanical principles of coking, and apply this knowledge to the construction of an apparatus and to its manipulation.

Ordinarily analyses of coals embracing Carbon, Sulphur, Ash and volatile matter, is entirely worthless for a new field. The composition of the ash need not be ascertained, but the composition of the volatile matter cannot be too carefully determined; also at what temperature these volatile products are driven off; whether the heats were applied regularly throughout the mass, transmitted

through the roof, walls and bottom of the vessel; applying intense heat at one portion and slow transmitted heat at another portion. The composition of coals which coke and which do not, are sometimes identical, and their frequent close approximation, has led to the supposition that the chemical structure alone affects their coking properties.

In the wide range of coals, however, there is a marked difference in the composition of the dry burning and caking coals.

The close similarity in composition led me to call special attention to the analysis of the volatile matter evolved under different conditions. That such modification in practice may be attempted as will give off from coals under consideration, gases similar in composition to those evolved from strictly coking coals. This may or may not be practicable, but its attempt would be worth while and might lead to some good results. We must not assume that like heats will affect different varieties of coals similarly.

Percy's Metallurgy; Fuel, 1875, thus describes coking in the Bee-Hive; page No. 420:

"Let us suppose coal piled to the thickness of two or three feet in a fire-brick chamber, entirely closed, with the exception of a hole in the top to act as a chimney, and a few small openings through which air from without may enter above the surface of the coal; and let us further suppose, that the whole of the upper part of the coal is burning actively, that air to sustain combustion is entering through the small openings, and that the volatile products of combustion are escaping through the hole at the top. The oven above the coal will speedily be heated to redness, and the heat will be propagated downwards through the coal, of which every portion will be successively subjected to destructive distillation. The volatile products from below will ascend through the red-hot overlying stratum of coked coal, and, protecting it from contact with atmospheric air, will prevent it from burning to waste. But as these products have been formed at a much lower temperature than that prevailing in the upper part of the oven, they may be so rich in carbon as to be decomposed in their ascent, and deposit a portion of their carbon upon the coke which they traverse. The deposited carbon is generally bright and almost metallic in lustre; the coked coal will be coated with a deposit of this lustrous carbon, while the more or less decarbonized resid-

ual gases will take fire as they escape from the incandescent mass and come in contact with the air, which enters through the small openings above its surface."

All the heat is obtained from the combustion of Hydrogen or light Hudro-carbons, and this heat is transmitted by reflection from the arched dome to the fuel, carrying the evolution of the gases slowly downward, and as they rise they are burned, keeping up the heat necessary to the process. The quotation leaves the impression that no solid carbon is consumed, which no doubt is true, during the time that this is a true description of the process. During the last stage, however, when the quantity of gas being evolved is small, air does come in contact with the incandescent carbon, and a very considerable quantity is burned before the full carburization can be affected at the bottom of the oven. This combustion is essential to the maintenance of sufficient heat when the ovens are worked without the aid of gas from contiguous ones. Much of the complication of ovens seeking to save the waste of carbon, might be avoided by utilizing the gases from the other ovens, when the internal supply is failing to keep up the requisite temperature.

The quotation above referred to does not commence with the beginning of the process, and to my mind avoids the most important portion, namely, the agglutination of the charge of coal. If dry burning coal be charged into the oven, the coke produced will be of the form of the piece of coal or further broken. To obtain a merchantable coke a semi-fusing of the mass must be affected, forming one cake of coal. In this condition the gases are passing off, and the mass raises as in baking bread. This is the expansion of the coal. As the heat is applied to the top the gas leaves that portion first, and the mass shrinks, gather together horizontally as the action of the heat is upon the horizontal surface; hence the columnar structure and large pieces of coke, each piece being almost homogeneous, so far as showing any trace of the original lumps. The essentials to coking would therefore seem to be a semi-fused or agglutinated mass, and heat sufficient to carry on the elimination of the volatile materials from the mass to a practical completion with the consumption of the least carbon.

We do not speak of the latter of these propositions, as it seems to me that if the first condition can be reached, a good tenacious coke can be readily obtained.

When coke of an especially non-coking quality is charged to a furnace, it is immediately permeated with a stream of non-oxidising gas of such great volume and weight that the coal is rapidly and completely heated throughout to an oven temperature. In a reasonably economically working furnace these gases will not exceed 500 deg., F., when leaving the furnace. As the charges descend the heat rapidly increases, but it is an uniform increase throughout the mass, yet no combustion takes place that could effect the mass of coal. If a bar of iron be driven into this furnace it would be found to penetrate an agglutinated mass, and the bar upon being withdrawn would be covered with a tarry substance. The charges descending further soon reach a zone of heat sufficient to drive off these gases, and a fairly good coke is found on the hearth, performing all the requirements of the blast furnace. It is a fact that dry burning coal, impossible to coke in any ordinary coking furnace, is effectively and rapidly coked in the blast furnace. In a blast furnace with 100 feet average area, 200 tons of coal be charged in twenty-four hours, and the coking operation must be completed in eight hours from the introduction of the fuel. It seems possible that in this operation we have the elements of a true coking process, and it is of importance that each step in the action should be investigated, that its duplication may be effected without the consumption of the coke.

The coking zone cannot exceed 15 feet in height, hence each seven feet of cubical contents of the space partly occupied by ore and limestone effects the coking of a ton of coal each six hours.

It may be that all the disposable hydrogen takes up a large proportion of carbon, forming heavy hydro-carbons, and the mass thereby becomes pasty. These hydro-carbons being retained in the furnace by the additional charges which intercept them, but have not a temperature to gasify them rapidly. They thus serve to cement these coals as they become hotter and are only given off after aerating their purpose of agglutination.

It may be there is an accumulation of these heavy hydro-carbons until an amply sufficient quantity for the process is obtained, the over-plus only being cast off by the furnace. This process seems open to the objection that all the carbon of the hydro-carbons is finally driven off, instead of the decomposition returning a large portion of their carbon to the coke, a waste which is much greater than the combustion of the carbon by the air in the ordi-

nary coke oven practice, though in the blast furnace none of the solid carbon is lost.

The fact that ordinary coals are agglutinated must not be lost sight of, and the essentials for this agglutination striven for, while the saving of the carbon of the gases is kept in view. Furthermore, great length of time is not necessary to the production of good coke, it is only the accompanying result of the systems adopted. Forty-eight hours may be needed in coking in the Bee-Hive, but so long a time is not required by other processes, and in the blast furnace the work is done in—say eight hours.

Comparing the period of agglutination in the ordinary coke ovens with the blast furnace herein described, we find this difference, that in the coke ovens a heat of considerable intensity is applied to one portion of the coal, while by the balance there is little or no heat received. This irregular application of heat may cause such difference in the development and evolution of the hydro-carbons as to very much impair their efficacy for fusing the mass; whereas it may be that in good coking coals, these hydro-carbons are practically formed within the coal, when their active development and fusing qualities would not be so easily impaired.

Purity of coals from ash and sulphur is not so important as effecting coking; but the purer they are for the same quality of coal, the more easily is good coke produced, but the purity of the coke is so very important an item when its value is considered, that considering the great perfection to which washing machinery has been brought, it is surprising so little is done in getting rid of these impurities. One of the most simple contrivances, perfected by Bell Bros., (I Lowthian Bell) England, gets rid of 70% of these ingredients. The plan is exceedingly simple, cheap and durable. Other plans, such as the copper system, is washing coal with 10% impurities, and producing coke with 9%. This is better than our Connellsville coke, which seldom has less than 11%.

Coals of a much inferior grade to those of Ohio, produce good coke in Europe by using coke ovens having the heats of their gases applied externally to the coke chamber, either on the sides, roof or bottom, or any two of these; the coals, however, are always carefully crushed and washed.

All coke oven inventors seek heat as their salvation in coking coals of a semi-coking character, but my view is that high heating is essential at the final stages only, and that most attempts have

proven abortive by using high heats at the commencement of the process, and in not being able to heat the mass evenly through and through. Indeed, it seems, reasoned from the blast furnace, operation, that the application of the heat must be gradual and even, distributed by commencing at a low temperature, but it will not matter how fast it is applied, if each lump of coal can be heated to practically an even temperature to its very center.
